CLAIMS

1. A multi-state, multi-layer magnetic memory device comprising:

a nonmagnetic spacer region with a surface and an opposed surface;

a free magnetic region positioned adjacent to the surface of the nonmagnetic spacer region, the free magnetic region including a plurality of magnetic layers; and

wherein a free magnetic layer positioned adjacent to the surface of the nonmagnetic spacer region in the plurality of magnetic layers has improved material quality.

2. A device as claimed in claim 1 wherein the thickness of the magnetic layer positioned adjacent to the surface of the nonmagnetic spacer region in the plurality of magnetic layers is in a range approximately from 40 Å to 120 Å and the improved material quality is obtained through increasing the thickness.

3. A device as claimed in claim 1 wherein the magnetic layer positioned adjacent to the surface of the nonmagnetic spacer region in the plurality of magnetic layers is of a material having improved growth characteristics on the nonmagnetic spacer.

4. A device as claimed in claim 3 wherein the magnetic layer positioned adjacent to the surface of the nonmagnetic spacer region in the plurality of magnetic layers is an amorphous magnetic alloy.

5. A device as claimed in claim 1 wherein the magnetic layer positioned adjacent to the surface of the nonmagnetic spacer region in the plurality of magnetic layers is deposited or annealed at temperatures greater than 100C.

6. A device as claimed in claim 1 wherein the free magnetic region includes at least one layer of an anti-ferromagnetic coupling spacer material.

7. A device as claimed in claim 6 wherein the anti-ferromagnetic coupling spacer material includes at least one of copper (Cu), silver (Ag), gold (Au), chromium (Cr), ruthenium (Ru), rhenium (Re), osmium (Os), titanium (Ti), chromium (Cr), rhodium (Rh), platinum (Pt), palladium (Pd), and alloys thereof.

8. A device as claimed in claim 1 wherein the free magnetic region includes at least one of nickel (Ni), iron (Fe), cobalt (Co), manganese (Mn), combinations thereof, and alloys thereof.

9. A device as claimed in claim 1 wherein the free magnetic region includes a synthetic anti-ferromagnetic material region including N ferromagnetic layers which are anti-ferromagnetically coupled where N is a whole number greater than or equal to two.

10. A device as claimed in claim 9 wherein each N ferromagnetic layer is anti-ferromagnetically coupled by sandwiching a layer of an anti-ferromagnetic coupling material between each adjacent ferromagnetic layer in the N ferromagnetic layers.

11. A device as claimed in claim 1 wherein a fixed magnetic region is positioned on the opposed surface of the nonmagnetic spacer region.

12. A device as claimed in claim 1 wherein the nonmagnetic spacer region includes at least one of aluminum oxide (AlO), aluminum nitride (AlN), silicon oxide (SiO), and another dielectric material which form a tunneling barrier with each adjacent region.

13. A device as claimed in claim 1 wherein the nonmagnetic spacer is a conductive material including at least one of copper (Cu), chromium (Cr), silver (Ag), and gold (Au).

14. A device as claimed in claim 9 wherein the one ferromagnetic layer of the synthetic anti-ferromagnetic material region that is positioned adjacent to the surface of the nonmagnetic spacer is at least as thick as any of the other N ferromagnetic layers which comprise the synthetic anti-ferromagnetic material region.

15. A plurality of magnetic memory devices with a magnetic switching field and a magnetic switching field variation, each device comprising:

a nonmagnetic spacer region with a surface and an opposed surface; and

a free magnetic region, the free magnetic region being positioned on the surface of the nonmagnetic spacer region, the free magnetic region includes a first magnetic layer with a thickness positioned adjacent to the nonmagnetic spacer region and a second magnetic layer with a thickness wherein the first and second magnetic layers are separated by a spacer region, wherein the thickness of the first magnetic layer is substantially greater than the thickness of the second magnetic layer, the thickness of the first magnetic layer being chosen to obtain a desired magnetic switching variation.

16. A device as claimed in claim 15 wherein the thickness of the first magnetic layer is in a range approximately from 40 Å to 120 Å for each magnetic memory device in the plurality of magnetic memory devices.

17. A device as claimed in claim 15 wherein the anti-ferromagnetic spacer region includes an anti-ferromagnetic coupling spacer material.

18. A device as claimed in claim 17 wherein the anti-ferromagnetic coupling spacer material includes at least one of copper (Cu), silver (Ag), gold (Au), chromium (Cr), ruthenium (Ru), rhenium (Re), osmium (Os), titanium (Ti), chromium (Cr), rhodium (Rh), platinum (Pt), palladium (Pd), and alloys thereof.

19. A device as claimed in claim 15 wherein the thickness of the first magnetic layer is in a range approximately from a factor of one and one-half times the thickness of the second magnetic layer to a factor of three times the thickness of the second magnetic layer.

20. A device as claimed in claim 15 wherein a fixed magnetic region is positioned on the opposed surface of the nonmagnetic spacer region.

21. A device as claimed in claim 20 wherein the nonmagnetic spacer region includes at least one of aluminum oxide (AlO), aluminum nitride (AlN), silicon oxide (SiO), and another suitable dielectric material which forms a tunneling barrier with each adjacent region.

22. A device as claimed in claim 20 wherein the nonmagnetic spacer is a conductive material including at least one of copper (Cu), chromium (Cr), silver (Ag), and gold (Au).

23. A method of fabricating a plurality of magnetic memory devices with a magnetic switching field variation, the method of fabricating each magnetic memory device in the plurality of magnetic memory devices comprising the steps of:

providing a nonmagnetic spacer region with a surface and an opposed surface; and

positioning a free magnetic region, the free magnetic region being positioned on the surface of the nonmagnetic spacer region wherein the free magnetic region includes a plurality of magnetic layers and wherein a magnetic layer in the plurality of magnetic layers positioned adjacent to the nonmagnetic spacer region has a thickness substantially greater than a thickness of the magnetic layers subsequently grown thereon to obtain a desired magnetic switching field variation.

24. A method as claimed in claim 23 wherein the thickness of the magnetic layer positioned adjacent to the nonmagnetic spacer region in the plurality of magnetic layers is in a range approximately from 40 Å to 120 Å for each magnetic memory device in the plurality of magnetic memory devices.

25. A method as claimed in claim 23 herein the free magnetic region includes at least one layer of an anti-ferromagnetic coupling spacer material.

26. A method as claimed in claim 23 wherein at least one layer of the anti-ferromagnetic coupling spacer material includes at least one of copper (Cu), silver (Ag), gold (Au), chromium (Cr), ruthenium (Ru), rhenium (Re), osmium (Os), titanium (Ti), chromium (Cr), rhodium (Rh), platinum (Pt), palladium (Pd), and alloys thereof.

27. A method as claimed in claim 23 wherein the free magnetic region includes at least one of nickel (Ni), iron (Fe), cobalt (Co), and alloys thereof.

28. A method as claimed in claim 23 wherein the free magnetic region includes a synthetic anti-ferromagnetic material layer that includes N ferromagnetic layers which are anti-ferromagnetically coupled, where N is a whole number greater than or equal to two.

29. A method as claimed in claim 28 wherein each N ferromagnetic layer is anti-ferromagnetically coupled by sandwiching a layer of an anti-ferromagnetic coupling material between each adjacent ferromagnetic layer in the N ferromagnetic layers.

30. A method as claimed in claim 23 further including the step of providing a fixed magnetic region positioned adjacent to the opposed surface of the nonmagnetic spacer region.

31. A method as claimed in claim 23 wherein the nonmagnetic spacer region includes at least one of aluminum oxide (AlO), aluminum nitride (AlN), silicon oxide (SiO), and another suitable dielectric material which forms a tunneling barrier with each adjacent region.

32. A method as claimed in claim 23 wherein the nonmagnetic spacer is a conductive material including at least one of copper (Cu), chromium (Cr), silver (Ag), and gold (Au).